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Economic Efficiency Role in Sustainable Water Development of Retail Water Providers in the West Bank and Gaza Strip in Palestine

دور الكفاءة الاقتصادية في التنمية المائية المستدامة لمزودي المياه بالتجزئة في الضفة الغربية وقطاع غزة في فلسطين

Fuad Y. Rammal[1,*] & Bouchta Alkhazzan[1]

فؤاد رمال[1]، وبوشته الخزان[1]

[1]Department of Geography, College of Arts and Humanities. Dhar Al-Mahraz, Sidi Mohamed Bin Abdullah University, Fez Morocco

[1]قسم الجغرافيا، كلية الآداب والعلوم الإنسانية، ظهر المهراز، جامعة سيدي محمد بن عبد الله، فاس، المغرب

*Corresponding author: fuad_alramal@yahoo.com

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Abstract

It’s widely recognized that within the water sector, economic efficiency can affect the inputs and outputs of the water supply and sanitation service facility. However, based on an interactive situation that requires adjusting the inputs based on the targeted outputs and compared to counterpart facilities, which may create price restrictions that affect the economic sustainability within the water sector. Hence, this study aimed at revealing the economic efficiency role in sustainable water development, for the major water service providers in the West Bank and Gaza Strip in Palestine. The research adopted a combined approach (i.e., quantitative and qualitative) by analyzing the Council's data, which tracks all activities of the Retail water providers, through the **DEAP** program. Preliminary results have shown that seven of eleven providers do not cover operational costs. Moreover, the economic efficiency ratio (EER) has decreased from (78%) when calculated using five operating cost inputs to (66%) when highlighting the relative weight of both allocative and technical efficiency to, finally, (58%) when unwanted outputs (i.e., outputs over 100%) were excluded, as it considered as an unbalance in the distribution of inputs compared to outputs. Results has also emphasized the role of economic efficiency as the main driver for sustainable water development by linking efficiency and importance of water to general welfare. Finally, this work recommends adapting a three crossover-model style that fucus on management, market needs and society as a direct indicator for pricing equity within the water and sanitation sectors in Palestinian. Such approach would ensure a holistic input for s strategic management changes in water sustainability, which requires a collaborative vision by all involved parties including government agencies and decision makers.

Keywords: Economic Efficiency, Retail water providers, Sustainable Water Development.

ملخص

هدفت الورقة الى الكشف عن دور الكفاءة الاقتصادية في التنمية المائية المستدامة، لدى كبار مزودي خدمة امدادات المياه بالمفرق، في الضفة الغربية وقطاع غزة في فلسطين، والذي يبلغ عددهم (11) موزعا بتجانس جغرافي يطال الضفة الغربية وقطاع غزة، حسب تصنيف مجلس تنظيم قطاع المياه والصرف الصحي الفلسطيني، وقد اتبع البحث المنهج النوعي، بتحليل بيانات المجلس، التي ترصد كافة أنشطة مزودي المياه بالمفرق (الكمية والنوعية)، من خلال برنامج مغلف البيانات (DEEP) لتحليل بحوث العمليات، وقد اظهرت نتائج التحليل، أن سبع مزودين لا يغطون التكاليف التشغيلية، وأربعة فقط من يغطون هذه التكاليف، في حين قلت نسبة الكفاءة الاقتصادية من (78%) عند احتساب خمس مدخلات تختص بالتكلفة التشغيلية، الى (66%) عند ابراز الوزن النسبي لكل من الكفاءة التخصيصية والفنية، وقلّت الى (58%) باستبعاد مخرجات غير مرغوب فيها (المخرجات التي زادت عن 100%) باعتبارها اختلال في توزيع المدخلات نسبة الى المخرجات، ويقتضي التوزيع لكل منشأة زادت نسبة استردادها للتكاليف التشغيلية عن 100% ان تعطي وزنا اكبر لمدخلاتها. وقد استنتج البحث أن الكفاءة الاقتصادية معزز كبير للتنمية المائية المستدامة ويتعدى الدور ليشمل التنمية المستدامة لقطاعات أخرى، من خلال ربط الكفاءة الاقتصادية بمضاعف رفاهية المياه للمجتمع، لدخول المياه في جميع القطاعات، خصوصا وان ميزان التسعير العام للمزودين خاسر بمقدار 29%، وقد أوصى بضرورة تبني ثلاث نماذج هجينة لضمان الاستدامة المائية، تركز على **الإدارة والسوق والمجتمع**، وفقا لمعايير واضحة تحقق العدالة السعرية للمياه والصرف الصحي، في قطاع المياه الفلسطيني، كمدخل شمولي لإدارة التغيير الاستراتيجي في الاستدامة المائية، والذي يتطلب تعاون قطاعي ووزاري مع كافة اطراف التأثير المحتملة.

الكلمات المفتاحية: الكفاءة الاقتصادية، مزودي المياه بالتجزئة، التنمية المستدامة للمياه.

Introduction

Household income varies considerably in the West Bank and Gaza Strip in Palestine with a weak economy widely characterized as a low- to middle-income region. Palestine is located in an area widely characterized by arid and semiarid conditions, where water scarcity is a limiting factor to most prevailing economic activities. Importantly, the Israeli occupation add considerable restrictions to such scarce resources (Palestinian Water Authority, 2020) leading to a highly vulnerable geopolitical environment. While ensuring water security in Palestine should be considered a priority, it is currently marginalized and weak. Water security requires proper management of resources, including efficient management of water services (World Bank, 2018) by local providers, who are responsible for providing a sustainable, effective, and fair service.

The rate of groundwater extraction permitted by the Israeli occupation in the West Bank area for Palestinian use is estimated at about 120 million cubic meters in 2020, of which 30 million cubic meters came from agricultural wells, 50 million cubic meters from drinking wells, and 40 million cubic meters from surface water and springs. However, this rate has exceeded 170 million cubic meters in the Gaza strip in the same period of which 97% is unfit for human consumption. With the aim of reducing the water deficit within the Palestinian communities, the Palestinian Water Authority has purchase over 70 million cubic meters from the Israeli Water authorities (Palestinian Water Authority, 2020). This model should be managed in a framework of relatively high economic efficiency.

Economic efficiency is generally defined as the case in which society receives the highest level of social welfare from its limited resources. Economic efficiency levels include efficiency at the sector (mizo) and corporate levels (micro), efficient allocation of goods and services among consumers (micro, mizo, macro), and efficient overall allocation of various sectoral national resources (macro) (Gunatilake, *et al*. 2008). Hence, the best way to allocate resources is to maximize the social welfare of the targeted group, also called extensive economic efficiency at all identified levels (Al-Rai, *et. al.* 2020). Such efficiency would include technical and specialized ones, indicating to input efficiency and its optimal allocation proportion to output without entering process efficiency, while entering into the calculation of the economic efficiency of operations. This is an economic efficiency according to the network calculation of efficiency and has its own specialized software (Ropert, *et al*. 2017).

Providers of water service are widely represented by municipalities, local councils and water authorities, which have been established by a formal law (Palestinian Water Authority, 2014) and its scope of administration includes specific areas of royalty for each geographical region. This may be described as a kind of market monopoly, which may not lead to provide high levels of economic efficiency to produce below the optimal level, which is determined by economic efficiency calculations and usually accompanied by higher pricing. Such management may in turn adversely affects the level of welfare, in spite of higher profits for the plant in this case. However, society profit is lower, not to mention the unbalanced equity of allocation justice controls in the utilization of resources and services for all groupings (Alawna & Shadeed, 2021).

Since economic efficiency is determined by the level of satisfaction with services and the degree of welfare that society enjoys in satisfying its needs, through the optimal distribution of these resources by providers (Al-Rai, *et. al*. 2020), the main objective of this paper is to reveal the real level of economic efficiency of water service providers in the West Bank and Gaza Strip in Palestine. This will be marked through the following question: What is the role of economic efficiency in sustainable water development in water service providers in West Bank and Gaza Strip in Palestine?

In general, economic efficiency as a concept often guides economic policies around the world. Importantly, widely observed empirical evidence confirms that market economies with the correct political interventions exert a significant influence on the development of countries (Gunatilake, *et al.* 2008). This empirical guide reinforces the importance of the concept of economic efficiency, which is linked to water sustainability and focusing on three interlinked axes including economic efficiency, social justice and cost recovery (United Nations, 2017), as a major guarantee of the financial sustainability of water resources distribution. All is taking place within a systematic and planned reality by the Israeli occupation to destroy all aspects of sustainability of Palestinian resources by various means including the confiscation of lands, building illegal settlements and colonies blocking all geographic and demographic connections and movements and placing restrictions on importing needed technology for water facilities (Abuassida & Jalloul,2022).

Methodologies and analysis tools

In Palestine (Figure 1), water providers can be classified as small, intermediate and large providers, according to the official classification (Water Sector Regulatory Council, 2021). Current paper will focus only on the largest water providers, represented and distributed across all geographical regions in Palestine. Basically, the study of the major providers will involve (i) analyzing the details of their economic efficiency to determine economic gaps, which do not represent the optimal allocation of resources, and (ii) linking it to the value of pricing and recovery of operational costs. In order to achieve this, a group of general indicators will be implemented as surrogates for the above gaps and their links using data extracted for the periods 2019-2020. This period represses stage in which information coordination between providers and the Water Sector Regulatory Board was kept in its actual form.

For this purpose, research will adopt a combined approach (i.e., qualitative and quantitative), by reclassifying and analyzing this data according to economic efficiency controls. This should allow for (i) conclusions on optimal material use, (ii) level of economic efficiency achieved, (iii) comparison on similar supply facilities, and (iv) linking them to water sustainability requirements of water providers.

Data Envelope Analysis Program (DEEP) of economic efficiency would be used to analyze data, as well as the use of approved mathematical tools and concepts for certain evidences, monitoring patterns and correlated relationships, and comparing results with previous studies of the same scope of research.

As such, the research hypothesis will be defined as follows: “The economic efficiency of the major water providers in the West Bank and

Gaza Strip have a role to play in promoting water sustainability in the Palestinian's water sector, which has a direct and crucial impact on the sustainability of other sectors of the society".

Indicators of economic efficiency

Palestinian Water Sector Regulatory Board, which control and monitor the performance of water service providers, has developed key performance indicators (KPIs) (Palestinian Water Authority, 2014a). These KPIs measure supply efficiency of water providers, which, accordingly, may imply variations in their levels, targeting areas and the focus points on which they were built. Consequently, this paper has reclassified these indicators to make sense in the evaluation of the economic efficiency of water, which is based on a thorough review of the Water Services Regulatory Council dataset in Palestine by the researcher (table 1a & 1b).

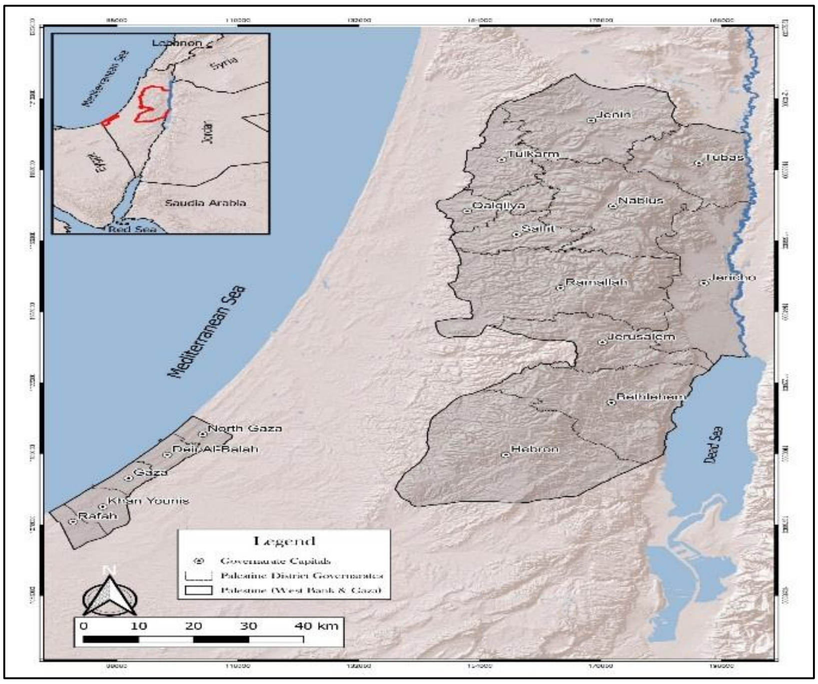

Figure (1): Palestine location and administrative boarders and limits.

0**Table (1a)**: outputs indicators table for major retail water providers in West Bank and Gaza Strip.

Indicators	Outputs of major retail water providers in West Bank and Gaza Strip										
	Rafah	Hebron	Jenin	Jericho	Jerusalem	Nablus	Qalqilya	Salfit	Tubas	Tulkarm	Bethlehem
Sewerage Coverage (Based on population served by water network (%)	0.926	0.835	0.771	0.171	0.000	0.970	0.968	0.571	0.000	0.700	0.892
Ratio of Domestic Consumption (%)	0.972	0.917	0.918	0.942	0.888	0.911	0.957	0.904	1.000	0.590	0.927
Staff Productivity Index "Water Service" (No.)	2.440	2.390	5.750	0.000	3.820	6.610	2.560	2.790	3.540	5.000	2.980
Average daily water consumption per capita at domestic level (l/c/d)	81.84	57.51	65.71	154.72	83.04	82.16	169.42	110.83	68.92	74.24	69.81
Non-Revenue Water as a ratio (%)	0.375	0.360	0.596	0.276	0.281	0.355	0.255	0.127	0.363	0.486	0.392
Collection Efficiency Water Service (%)	0.317	0.499	0.509	0.662	0.800	0.581	0.671	0.488	0.822	0.327	0.534
Collection Efficiency Wastewater Service (%)	0.089	0.000	1.022	0.624	0.000	0.569	0.736	0.447	0.000	0.000	0.769
Average Selling Price per cubic meter of water sold (NIS/m3)	1.380	5.390	5.450	2.820	6.890	7.060	1.780	4.190	5.460	3.660	7.080
Average daily water sold per capita based on total population (l/c/d)	83.12	62.61	71.52	198.21	101.44	90.10	179.96	122.58	69.88	132.59	77.86
Average daily water production per connection (l/c/d)	1348.18	1060.14	969.46	0.000	745.75	659.83	1194.45	609.65	581.28	1397.09	1157.89
Average daily water consumption per connection (l/c/d)	842.16	678.56	391.86	0.000	535.95	425.40	889.99	532.32	370.55	718.56	631.20

Table (1b): outputs indicators table for major retail water providers in West Bank and Gaza Strip.

Indicators	Inputs of retail water providers in West Bank and Gaza Strip										
	Rafah	Hebron	Jenin	Jericho	Jerusalem	Nablus	Qalqilia	Salfit	Tubas	Tulkarm	Bethlehem
Operating costs per cubic meter of water sold (NIS/m3)	1.440	7.430	7.950	3.270	7.740	5.510	1.210	3.360	6.560	2.070	8.030
Personnel costs per cubic meter of water sold (NIS/m3)	0.550	1.070	1.390	1.010	2.070	1.760	0.240	0.660	1.070	0.720	1.250
Water purchase costs (at purchase point) per cubic meter of water sold (NIS/m3)	0.040	5.030	3.160	0.000	3.500	0.290	0.000	1.670	4.310	0.000	5.440
Energy costs per cubic meter of water sold (NIS/m3)	0.490	0.480	0.200	0.430	0.590	2.480	0.530	0.130	0.140	0.520	0.370
Other operating costs per cubic meter of water sold (NIS/m3)	0.360	0.860	3.190	1.840	1.590	0.980	0.440	0.900	1.040	0.830	0.970
Operating costs per cubic meter of collected wastewater (NIS/m3)	0.000	1.740		0.470	0.000	0.000	1.270	0.000	0.000	0.500	0.720
Non-revenue water per connection per day (l/c/d)	506.0	381.6	577.6		209.8	234.4	304.5	77.3	210.7	678.5	453.6
Non-revenue water in m3 per km in the network per year (m3/km/ year)	8324.0	4929.0	13978.7	4730.3	3244.1	6779.4	8175.8	1213.4	2113.7	9677.5	5134.0
Water samples from network (taken including mains) containing free chlorine residual (RC) (%)	0.980	0.950	0.850	1.000	1.000	1.000	0.970	1.000	0.000	0.700	0.000
Water samples (taken at source) free from total coliform contamination (%)	0.850	1.000	1.000	0.000	0.000	0.830	1.000	0.960	0.940	1.000	0.000
Water samples (taken at source) free from fecal coliform contamination (%)	0.990	1.000	1.000	0.000	0.000	0.890	1.000	1.000	0.970	0.380	0.000
Working Ratio "Water Service" (No.)	1.020	1.250	1.320	1.090	1.010	0.750	0.650	0.740	1.120	0.540	1.120
Working Ratio "Wastewater Service" (No.)	0.410	1.190	0.090	0.870	0.000	1.500	1.150	0.290	0.000	6.580	0.710

Source: WSRC data (2021)

Following chart reflects table data as follows:

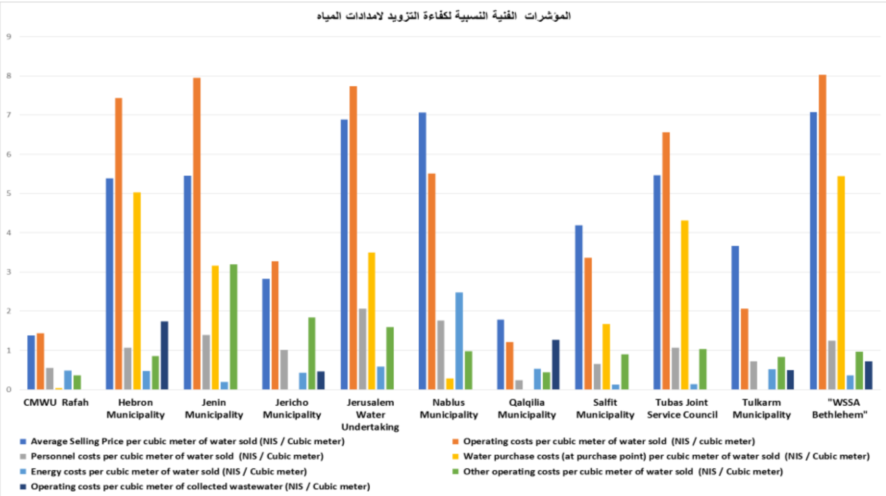

Figure (2): Comparative indicators of providing efficiency of water supplies. Source: data from Palestinian WSRC, designed by researcher.

Figure (2) shows that the cost of a cubic meter of potable water in its total form is considerably higher in Jenin, Hebron, Jerusalem and Nablus than other locations, which can be attributed to the costs of pumping from deep underground wells up to more than 1000m deep into the ground. In addition, the harsh geographical nature and rugged topography and mountainous ranges of Hebron, Bethlehem and Nablus play a role in increasing the costs. Although Jenin is located on an extended flat area, but is widely surrounded by mountains. Further analysis for other indicators is still needed to determine why the high total water cost, such as identifying how water tariffs adopted by each municipality was estimated, which may vary between one provider and another in the West Bank and Gaza Strip. These indicators could be widely related to historical accumulations most notably are the readiness to pay by service recipients, the level of water scarcity that increases as we head south in the West Bank. However, in Gaza there is a relative abundance of water but with poor quality.

Importantly, while considering other indicators, the rise affects the sales price index of cubic meters of water even within the same governorates, on the basis that first indicator was high, and therefore the provider must go after the steady rise in costs and linking it to the selling price of the service recipient, this causes pressure on the consumer bill and increases fears of low-income exposures to these high costs of receiving potable water or sanitation service.

A lower percentage of indicator levels has also been observed in the rest of the governorates within the study area (Fig.1). This observation could be attributed to various reasons, but mainly being rich in easy-to-produce water, which is widely available through underground wells and springs owned by the local municipalities. These municipalities seem to place greater emphasis on reducing other costs, such as the indicator of workers, employees, operation and maintenance costs, and energy among others.

It has also noted that the indicators mentioned in figure (2) have not distinguished between the basic input or output groups but rather addressed the components of each indicator through the performance level within the water and sanitation sector. Noting that they can be distinguished according to the input and output set, as well as differentiated according to the type of economic efficiency expressed by each indicator, which should provide a clear vision for decision makers. Such holistic vision and approach are best suited for the purposes of analysis and importantly to come up with the necessary recommendations that provide the level of real economic efficiency of the water supply and sanitation service.

In fact, this percentage of lost efficiency is charged to the facility’s total costs, thus reflecting its value in pricing. Therefore, pricing is fair according to valued economic efficiency. From this discussion, it can be said that the lower the economic efficiency ratio the more there is a price justice ramp (Erbetta & Cave, 2007).

The following table shows another set of technical indicators of the West Bank and Gaza Strip's for potable water supply:

Table (2): reflects the ratio of annual loss of distribution networks for major providers, as shown in following table.

"WSSA Bethlehem"	Tulkarm Muni.	Tubas J.S. C	Salfit Mun.	Qalqilia Mun.	Nablus Mun.	Jerusalem Water Undertaking	Jericho Mun.y	Jenin Mun.	Hebron Mun.y	CMWU Rafah
39%	49%	36%	13%	25%	36%	28%	---	60%	36%	38%

Source: developed by researcher by dividing annual loss quantity indicator on annual production indicator for each governorate, according to data stipulated in Palestine WSRC database.

Table (2) with connection to Figure (3) shows that the ratio of loss is very high and varies considerably among governorates, with lowest values is in Salfit municipality (13%) and the highest is in Jenin (60%). This rise in costs is attributed to technical reasons, such as old degraded networks, intermittent pumping in supply networks, and administrative aspects, the most important of which are accounting systems adopted by municipalities, which is considered either traditional or sophisticated.

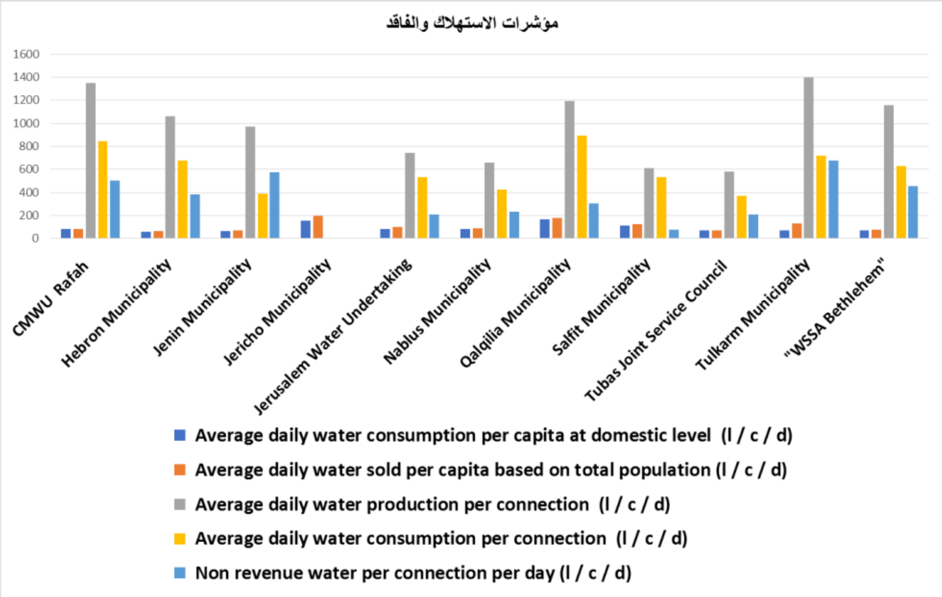

Figure (3): potable water consumption and loss indicators in the West Bank and Gaza Strip. Source: developed by the researcher from WSRC database (Palestine).

However, if ratios in (table 2) are linked to the concept of specialized efficiency, but isolated from other indicators, the ratio of loss should represent the level of specialized efficiency. Therefore, the allocation efficiency in the municipality of Jenin, for example as shown in table (2), is 40% through (1-60% = 40%) and the same is applied for the rest of the ratios in the table. For example, the municipality of Salfit represents highest efficiency allocation (1-13% = 87%). However, when this loss is quantified, the following table for each kilometer /year of distribution network is shown as follows:

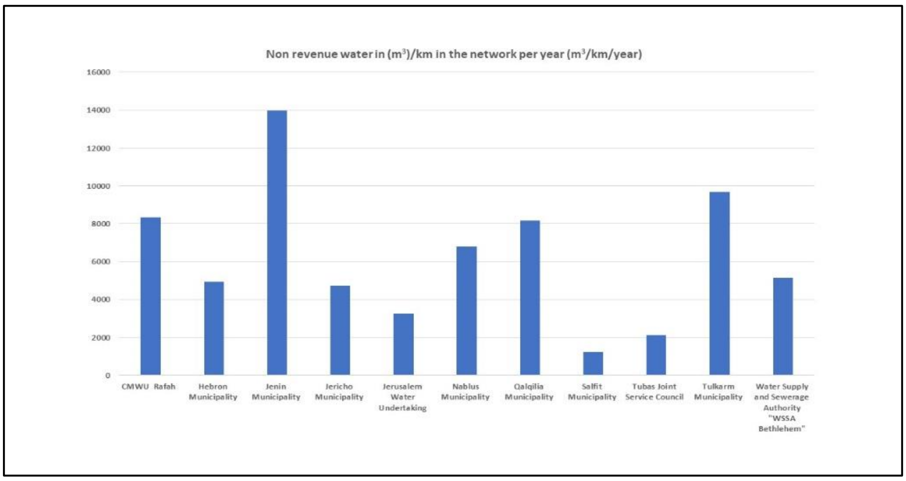

Figure (4): Nonrevenue water in the network per year (m"/km/year).
Source: developed by researcher.

In terms of quantity, figure 4 shows that the municipality of Jenin is the highest regarding the lost km/year and relative to the quantity of production and supply that it pumps into distribution networks, followed by Tulkarm, Rafah, Qalqiya and Nablus, respectively. This loss is associated with the quantity of production, meaning that the higher the quantity of production the higher is the quantity of loss, the change in the order of technical loss and the dysfunctional efficiency of the supply facilities.

This would lead to a higher proportion of charging for citizens in water pricing at a rate of 1/.6 = 1 .66. This is higher pricing is also linked to the loss in the level of water welfare, which is assumed by the community and end-users from the amount of water lost by multiplying the total loss of accumulation of water benefits deprived of society, as a result of multiple uses of water (i.e., the ability to utilize the same amount of water at a rate (1.66/0.6 = 2.76) as the minimum accumulation of water utility in society). Thus, this proposal would be considered in the assessment as an extension of the concept of dynamic efficiency, which supports the long-term accumulation of benefit and productivity in society (Greenwald & Stiglitz, 2013).

While pricing is affected by the cost of the water loss rate, which is charged to the water bill as part of the water service. This has a direct impact on other social, economic, and commercial activities. This loss is regarded as a deterioration of the welfare rate at which the value of water for the citizen and the social justice required is shared. Importantly, high water pricing would expose low-income individuals, as a result of fragility in resisting changes, and their low protection level, to meet the risk of capabilities to pay high prices.

The growing competition for freshwater in Palestine underlines the need for scalable solutions to manage and mitigate the effects of water scarcity. The regulations stipulated by international law can facilitate the transition to more sustainable water use patterns, including the reallocation of water to restore the Palestinian quota in the waters of the Jordan River (Zaytoon et al., 2005), and aquifers in areas already experiencing increased water extraction by the Israeli occupation, especially the western basin (Al Rammal & Al Khazzan, 2022).

Incentives can be developed in the water market, amidst the Israeli-Palestinian conflict, with focus on incentive-based methods, referred to by the indicators in figure 2 by water providers in the West Bank and Gaza Strip in Palestine. however, these incentives have struggled to expand beyond pilot initiatives mainly because of political resistance, lack of funding and data, and funding deficit ratios in the water sector (Palestinian Water Authority, Strategic Plan 2020).

Management by incentives to promote sustainable water development

Recent developments in our understanding of incentives for sustainable water use can help to overcome the persistent barriers that have hampered past efforts in the water and sanitation sectors, mainly in the Palestinian internal affairs. However, reflections of the current situation's dominant policy by the Israelis as an occupying Power (Palestinian Water Authority, Strategic Plan 2020) was established through a crossbred review to improve the overall economic efficiency of water plants in the Palestinian water and sanitation sector, and to set an agenda when intersected according to the following:

1. Incentive-based approach to water allocation and management (Anderson, *et al*. 2012).
2. Theory of Change approach to strategic development, impact and evaluation (Zilberman, 2008), allowing to identify incentive-based approaches to water allocation in a wider context by identifying potential synergies and frictions with a wide institutional and infrastructure processes reforms.

A clear focus on the theory-of-change approach can identify key assumptions and knowledge of gaps that may obstruct progress, such as social, economic, political, administrative and technical motivations, and empowerment conditions and sequencing issues for a different approach, in line with the water emergency in the West Bank and Gaza Strip in Palestine. This can be achieved by targeting the main factors blocking adoption in different contexts throughout the definition of three working areas, where multidisciplinary research (Karen, 2014) can support the development, implementation and evaluation of theories of change for water markets and water management based on other incentives such as:

1. Identify place and time of development of various types of incentives for sustainable water use by wholesale and retail water supply providers.
2. Design and testing incentives as part of a broader package of institutional reforms and infrastructure investments, in accordance with the integrated management concept adopted by the Palestinian Water Authority in its vision since its strategic plan 2014-2017.
3. Systematic assessment of the impact of incentives using diverse data sources using various collection, revision and analysis tools including regular and targeted surveys and field visits, down to satellite techniques and digitization of operations (Karen, 2014).

Economic efficiency analysis as a foundation for sustainability

The relationship of economic efficiency (technical and specialized) is contrary to financial sustainability as it imposes cost-recovery pricing in isolation from any negative conditions of the plant. In order to be fair, economic efficiency level needs to be raised to reduce the gap between cost-recovery pricing and price equity that enhances the optimal allocation of resources and therefore operational costs.

In this regard, several literature reviews have called for private sector intervention to increase the economic efficiency of water projects, mainly when resources are limited. Therefore, an increased rate of accessible economic efficiency in the case of water partnership projects, which can be a development intervention, leading to price fairness compared to current situation in the public sector (Pinto & Marques, 2017).

Figure (5) shows the ratio of operational cost coverage of water service providers compared to the sale price. Importantly, the coverage ratio for operational costs, which shows that only four providers cover operational costs with undesirable outputs in the concepts of economic efficiency, which is more than 100% to reflect an unbalance in the ratio of inputs to outputs. However, and based on table (3), in the event where the economic efficiency of the output of the sales price specified is calculated with five inputs associated with operational costs on the DEAP software, we will get the following table:

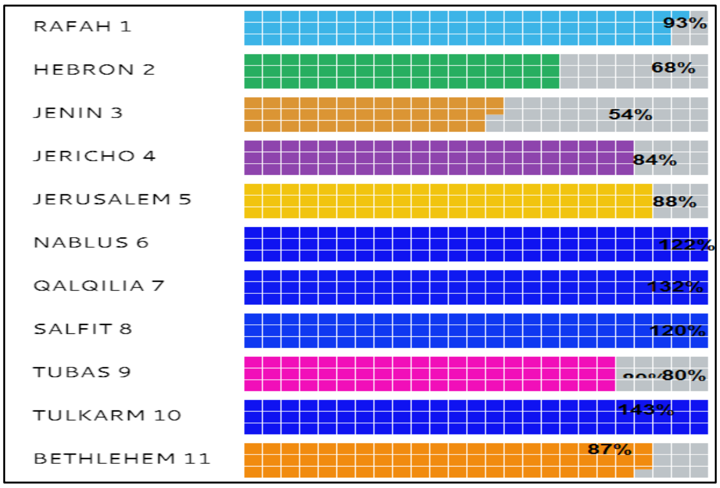

Figure (5): Ratio of sales price coverage of operational costs for major water service providers in the West Bank and Gaza Strip. Source: developed by researcher through review of last consequent three years ratio (2019- 2020 – 2021).

Table (2): Summary of input targets.

firm	input	Work % other o.c	o.cost/m3	Nis / m3. production.	enrgy cost/m3
1	1.020	0.375	1.440	0.040	0.490
2	0.874	0.252	5.195	2.919	0.336
3	1.320	0.596	7.950	3.160	0.200
4	1.090	0.276	3.270	0.000	0.430
5	1.010	0.281	7.740	3.500	0.590
6	0.750	0.355	5.510	0.290	2.480
7	0.650	0.255	1.210	0.000	0.530
8	0.740	0.127	3.360	1.670	0.130
9	1.120	0.363	6.560	4.310	0.140
10	0.540	0.486	2.070	0.000	0.520
11	1.120	0.392	8.030	5.440	0.370
Slacks calculated using multi-stage method					
EFFICIENCY SUMMARY:					
Firm			**te**		
RAFAH 1			0.542		
HEBRON 2			0.565		
JENIN 3			0.514		
JERICHO 4			1.000		
JERUSALEM 5			0.710		
NABLUS 6			1.000		
QALQILIA 7			0.898		
SALFIT 8			1.000		
TUBAS 9			0.748		
TULKARM 10			1.000		
BETHLEHEM 11			0.688		
Mean			**0.788**		

Source: developed by researcher

According to table (2), in the calculation of efficiency, which depends on linking the operational costs to sale price, the sale price as an output will determine the level of efficiency, with the output as the input size, to represent the ratio between the input and the output (sale price). This can be represented as (x) is the operating costs and (y) is the sale price.

This is linked to the volume of production and sales price of the total operating costs of the water plant as an indicator of economic efficiency in relation to operational costs for water providers in the West Bank and Gaza Strip in Palestine. However, if the total operating costs are assumed to be stable at a certain volume of production, impact on cost could be affected by time, with different production rates. This will lead to a general perception of how the water plant is moving in its future trends, if it maintains the same state and conditions (Gunatilake et al., 2008), which can be visualized in figure (6).

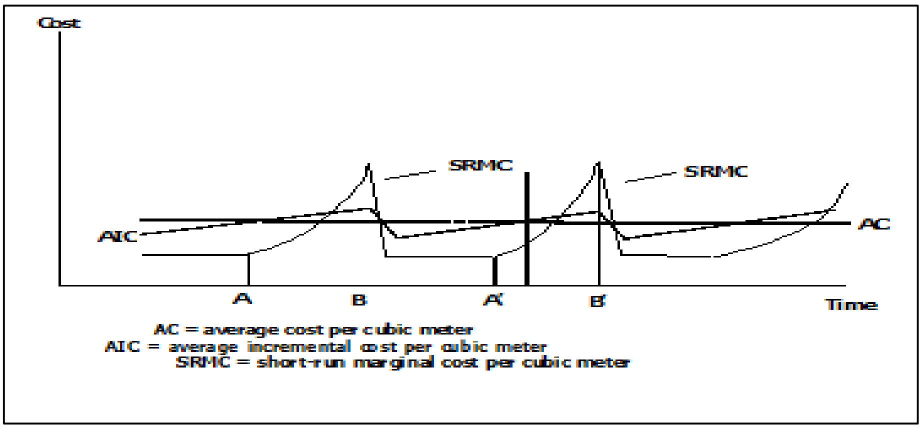

Figure (6): Variability of SRMC over time with capacity expansion. Source: ERD Technical Note series NO. 24

Figure 6 shows the impact of costs associated with the time factor, which linked costs to water plants in developing countries. This clearly highlight a considerable imbalance that threaten the sustainability of the water plant, due to the sale of its water services under operational costs at levels (A, A'). While plants selling at (B, B') levels would be considered safer than the previous level, this does not mean that they are more sustainable as economic efficiency is determined by the optimal way inputs are distributed at the lowest prices to maximize as much output as possible. This is clearly observed in figure (6) as it does not show the ratio of loss. However, when considering the ratio of cost recovery related to the ratio of loss (i.e., reflects the level of specialized efficiency of the water resources in terms of production and consumption), we obtain economic efficiency, which is estimated by multiplying technical efficiency in allocative efficiency. This is based on the assumption that the technical efficiency is associated with costs to achieve the lowest prices for service and the allocative efficiency is associated with optimal resource allocation and higher quality.

Economic efficiency is calculated using DEAP program and based on the below equation (Coelli,1996):

$$\text{Economic efficiency } = \text{Technical efficiency} * \text{ Allocative efficiency}$$

Table 4 shows all economic efficiency rates are calculated in relation to the ratio of loss and the price of sale relative to the operational costs of the providers of the governorate centers of the West Bank and Gaza Strip.

Table (4): Ratio of economic efficiency for retail water supply providers in the West Bank and Gaza Strip in Palestine. Source: developed by researcher.

Efficiency	**Rafah**	**Hebron**	**Jenin**	**Jericho**	**Jerusalem Water**	**Nablus**	**Qalqilia**	**Salfit**	**Tubas**	**Tulkarm**	**Bethlehem**
Allocative	62%	64%	40%	-------	82%	64%	75%	87%	64%	51%	61%
Technical	93%	68%	54%	84%	88%	122%	132%	120%	80%	143%	87%
Economic	58%	44%	22%	-	72%	87%	99%	104%	51%	73%	53%
General ratio for all providers	66 % without excluding undesirable outputs, and that exceeded 100%										

In general, table (4) shows the level of technical and allocative efficiency for each provider taking into account only the loss factor taken as an indicator of allocative efficiency and the cost recovery ratio as a technical efficiency indicator. However, it is important to note that if all technical and allocative indicators are added up together, the level of efficiency will change considerably. Nevertheless, this table gives only an overview of the level of efficiency in numbers, which is, in our case, 66% for all suppliers. This should give a clear perception of the magnitude of the loss incurred by the supply facilities. For example, if the percentage is calculated as a sum of money, at a 34% general ratio and for each $100 million the water sector is deprived of a welfare estimated at approximately $34 million. Importantly, it will not stand at this limit of loss because in exploiting the ratio as resources the "investment multiplier" is at its best (5), which is conceivable for loss as follows: 34% * 5 = 170% an estimated loss (non-utilization) of not raising the level of economic efficiency.

This loss will be noticed by all involved parties of the water system. For example, i) consumers of all sectoral will suffer in water scarcity high prices, and difficulties to obtaining and access, ii) providers will not be able to cope to demand with underfunded in cost recovery and asset sagging, weak response to growing demand, and, iii) the elevated government support and subsidies programs, which will increasing public deficit. Water welfare, being essential for all sectors within the society, will be negatively affected, which widely highlighted the importance of introducing economic efficiency requirements as a strong input for a nation's development progress. However, if we considered the 100% increase in profit shown in the supply facilities in table (4) as undesirable outputs for resource misallocation that can be interpreted as an indicator of the limited input required for the facilities, the economic efficiency rate will decrease to 58%. Thus, the ratio of deprivation of water welfare by applying the concept of investment multiplier to this assumption will increase to 210%. This is in the case where the investment multiplier would be accepted as 5 (Jhingan, 1983) at best (i.e., a multiplier ratio that largely applies to developing economies under effective governance). Yet, a ratio of 210% is estimated as 42 million to each 100 million, which means a total of 88.2 million of deprivation of the use of resources by society as a result of poor distribution, which has reduced the satisfaction of society's needs and is reflected in the level of economic efficiency of the 58%.

To adjust the cost conditions with the price, the intersections of price, production and cost need to be considered (figure 7).

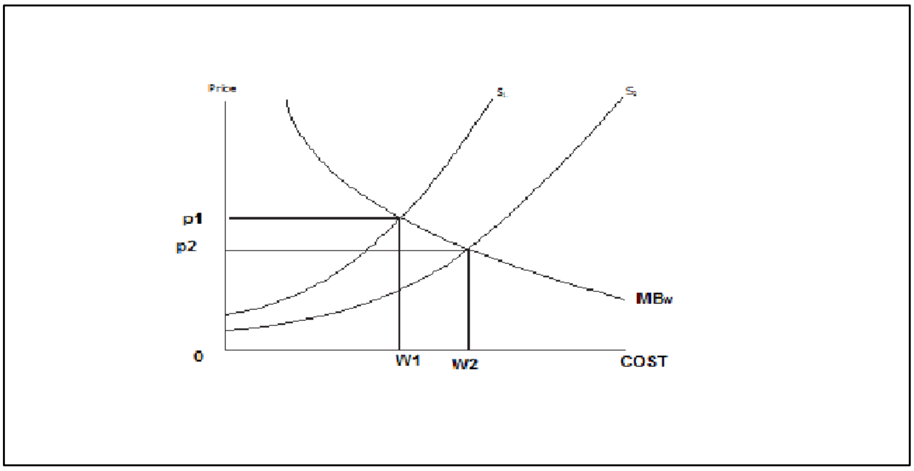

Figure (7): Function change curve for each provider associated with cost, price and production. Source: (Robert, *et al.* 2017).

Figure 8 shows the most important points that adjust the cost with price. Herein, the operational costs (MBw) will be the basis for determining the sale price for each provider (S), so that it adjusts the appropriateness of the price with the cost of production without loss. Hence, this requires reducing the costs per unit of water by treating it as an input and as an output according to the size and cost of the operating processes it has to qualify.

This trend in the analysis may explain some of the reasons for the varying prices and costs in the studies providers. This is basically explained by the different purchase price per cubic meter and the amount it supplies in each provider's franchise networks. This must be taken into account in the development of water policies in the exceptional circumstance facing water scarcity in Palestine and the geopolitical complexities imposed by the Israeli occupation on land, resources and communities in general. However, there are still cost control factors in the hands and under the control of the suppliers, including water redistribution, building standard methods to determine costs and fair pricing.

Figure 8 shows the situation of major water providers in West Bank and Gaza Strip in relation to pricing losses. Importantly, the position of the top studied providers relative to the lost pricing under which the operating costs incurred by the water facilities shows only four providers are located above the total costs and seven under the limit. This clearly indicate that these providers suffer a loss for each cubic meter of water provided in the distribution network, which explains why suppliers' debt has increased annually to reach approximately US $350 million in 2020 (PWA, 2020).

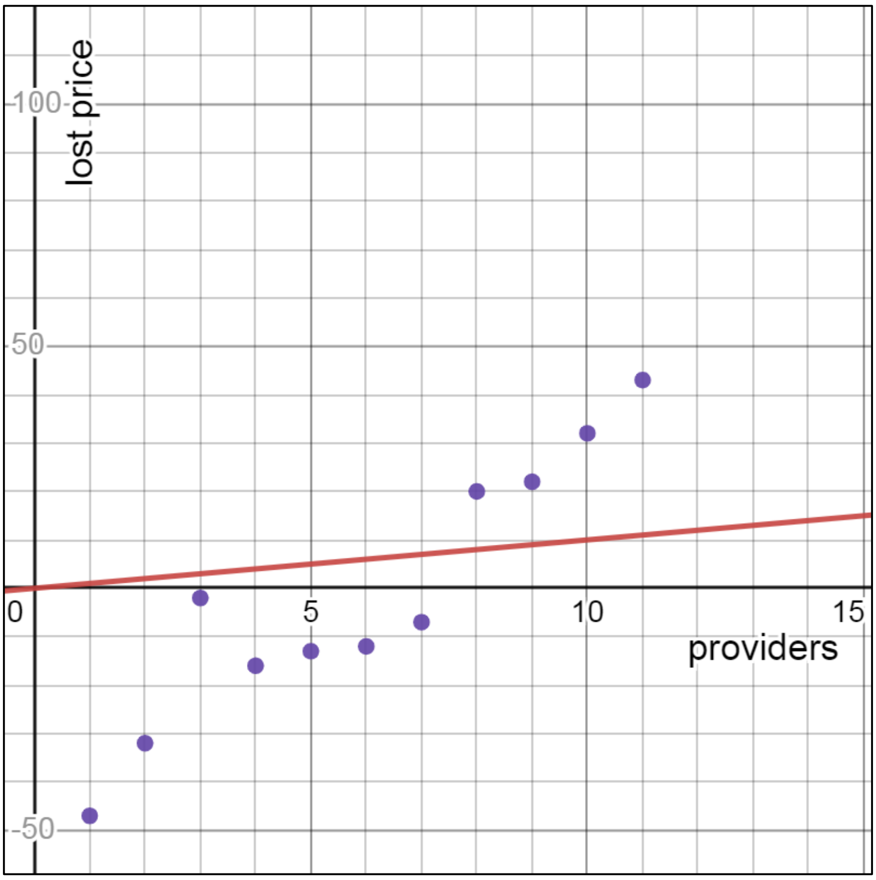

Figure (8): Curve of pricing ratio to operational costs (±) for each provider.

However, in case a balance was developed at the level of the top studied providers, the rate between + and - will be determined by the following equation:

$$\text{pricing balance} = \text{pricing ratio } (-) + \text{ pricing ratio } (+)$$

-1.46 + 1.17 = (-0.29) = 29% realized loss, per cubic meter of water, because there is no standard model for the development of fair pricing of water supply service, and until the differences in conditions surrounding pricing for each provider are overcome, it is possible to reallocate water (allocation), according to the usage pattern, in line with the fair tariff of water services.

It's widely acceptable that water redistribution allows changes in water use patterns, mainly in volatile supply and demand conditions, depending on market, management styles or communities focus-approach (Jordan, 2006), or often a combination of these to reduce risk. This combined approach is widely evident in the Palestinian situation that produces limited quantities of water, which is directly controlled by the Israeli occupation and its dominance on water resources.

Generally, reallocation is based on both increased supply and demand management, including ensuring fair accounting for operational costs, so that management reduces cumulative water consumption and promotes conservation through behavioral interventions, organizational changes and incentives, including grants and subsidies (Sahin, 2016). For this purpose, the water market and incentives are considered as complementary to increased supply and other demand management strategies, in accordance with economic efficiency and cost recovery requirements that ensure the financial sustainability of the supplying facilities.

For example, increased supply efficiency can lead to increases in total water consumption, unless efficiency investments are supported by behavioral changes. However, storage capacity can be confused through potential shortages, unless linked to demand management and effective allocation of all areas of water use (Sahin, 2016). Yet, within this approach, water users may adapt to average water supply conditions, without water retention, to prevent water overuse of limited groundwater sources and preserve freshwater ecosystems.

The fact that price equity of water consumption that is associated with the economic efficiency of water management affects increased supply, demand management and water reallocation (Yuan, 2019). However, demand management and water reallocation offer three distinct but interrelated approaches in response to water scarcity, in which increased supply will depend on technology and infrastructure, including dams, desalination facilities and distribution systems, particularly in Gaza Strip, which suffers from environmental disaster and general source pollution.

Under the above approach, economic efficiency may include i) the development of skills, expertise and knowledge, ii) the accumulation and strengthening of distinctive human capital, iii) the introduction of advanced techniques, and, iv) structured planning processes in integrated economic and social development. All these factors are required to ensure the optimal distribution of resources and the recruitment of funds in partnership with the private sector as an input to promote sustainable water development.

Results

Main results of this work can be summarized in two main sections:

1. It is clear that seven majors water supply facilities are selling under total operational costs, and the other four are selling above total operational costs (figure 8). This is all being done within unclear approach of calculating the total operational costs. Importantly, the percentage of water loss, which is averaged by providers on (36%) (table 2), is one of the most important allocation problems, for what is available of water resources, which reduces efficiency for supplying facilities.
2. The current work accepts the hypothesis of the existence role of economic efficiency among major water providers in West Bank and Gaza Strip in promoting sustainable water development. However, the degree of acceptance this role is limited to prevailed rate of the economic efficiency, which is at 58% as the lowest rate, excluding the undesirable outputs. This would indicate a growing loss and a fundamental imbalance in ensuring the sustainability of water providers services in the West Bank and Gaza Strip, which may affect negatively on water welfare for other sectors by 42%. All these effects will be reflected in a cumulative negative effect over time, where its impact can extend to threaten the sustainability of social and economic activities within society.

Conclusions and recommendations

Main conclusions of the present work can be summarized as follow

1. The sales price curve associated with covering operational costs within volume of production is governed by adjusting operating costs with volume of production, which reflects the level of fairness pricing of water service, where the general pricing balance of large suppliers was estimated at (-0.29) (29% loss).

2. The economic efficiency ratio decreased from (78%) when five inputs were used for operational cost to (66%) when highlighting the relative weight of both allocative and technical efficiency. However, the reduction was even higher and decreased to (58%) by removing undesirable outputs, due to i) inefficient allocation of these resources as it did not ensure their optimal distribution, and ii) technical efficiency that did not meet the cost coverage of most providers. These should increase the degree of assurance of the lack of water welfare, as it describes any intervention that would address the behavior of water poverty in society, reducing the gap in consumers' satisfying and declining economic efficiency, which may result in poor outcomes for water service providers. Thus, it will present a threat to sustainable water development and the risk of disruption of water supply service.

Based on the previous findings, the present work recommends the followings

1. Building a cross-hybrid incentive program that focuses on management, market and society, but at the same time ensuring the interests of the service users and providers within a sustainable water framework. This should always set to aim at achieving high levels of economic efficiency for the water supply facilities.

2. Developing standard methods that all water providers adhere to in calculating operational costs.

3. Focus on identifying the causes of water loss including technical, administrative and behavioral within distribution networks, and work to minimize them as much as possible.

4. Water decision makers are required to develop policies closely linked to the objectives and aspirations of other sectors regarding (e.g., domestic, economic and commercial) water needs. Importantly, a critical focus on organizes and regulates the administrative status of water providers, most of which are municipalities and local councils, though a broadly collaborative approach between the different involved administrations and ministries. Within this approach, more focus is also needed on agricultural irrigation methods. All the above should work as an input to rationalize the total consumption of water, which is directly increase the total amount of water available for other sectors.
5. The scarcity of water in Palestine as a result of Israel's dominance of resources requires a focus on the reuse of wastewater to be reused by other sectors including industrial and certain types of irrigated agriculture approved by the regulator.

Picture (1): Children taking turns filling drinking water in the Gaza Strip from a neighborhood watercourse. Source: Official website of Palestine State.

Ethics approval and consent to participate: All subjects gave informed consent for inclusion before participating in the study. The study was conducted in accordance with the ethics of Sidi Mohammed Ben Abdullah University/Fez/Morocco, and was approved.

Consent for publication: I, give my consent for the publication of identifiable details, which can include photograph(s) and/or videos and/or case history and/or details within the text (Economic Efficiency Role in Sustainable Water Development of Retail Water Providers in the West Bank and Gaza Strip in Palestine) to be published in the above Journal and Article.

Availability of data and materials: All primary data used in this manuscript can be accessed through the following website: http://wris.wsrc.ps/

Author's contribution: All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [**Fuad Yousef Rammal**].

Conflicts of interest: There is no conflict of interest with any party regarding everything contained in this manuscript, noting that the initial data that was used according to the database published on the official website of the Palestinian Water Sector Regulatory Council is available to everyone if requested in accordance with their approved procedures.

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